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January 5, 2007

Polly Lowry
Regional Water Quality Control Board
11020 Sun Center Drive #200
Rancho Cordova, California 95670-6114

Dear Ms. Lowry:

Waste Discharge Requirements General Order for Existing Milk Cow Dairies and Monitoring and Reporting Program No. __ General Order for Existing Milk Cow Dairies

We have reviewed the subject Waste Discharge Requirements and Monitoring and Reporting Program regarding Existing Milk Cow Dairies. Because of the high level of interest in the increased size and numbers of dairy operations in the San Joaquin Valley and because of the potential for existing dairies to substantially affect wildlife and fisheries resources on adjacent, nearby and land some distance away, the Department of Fish and Game (Department) offers the following comments regarding dairy operations impacts on fish and wildlife. We hope our comments will assist the Regional Water Quality Control Board (Board) reach appropriate findings regarding dairies.

General Comments

Over the years our Enforcement Branch (Wardens) have filed a number of water pollution cases associated with dairies illegally discharging their dairy waste into waters of the state. High concentrations of ammonia, increased salinity, and nutrient loading are three major concerns the Department has in relation to dairy waste discharges in to waters of the state.

Fish excrete unionized ammonia from their gills as part of their normal metabolic excretion of nitrogen waste. Toxic ammonia water concentrations can result in burning fish gills, decreasing their ability to excrete metabolic ammonia from their gills, decreases the uptake of oxygen through the gills, and can cause a reverse diffusion gradient and cause a build-up of ammonia in the gill tissue and blood. Clinical signs include the swelling of the gill tissues. Fish and other aquatic organisms exposed to elevated ammonia levels eventually die from suffocation. Milne et al. (2000) indicated that trout growth, gill condition, organ weighs and hematocrit were all significantly impacted as a result of repeated exposure to ammonia (Milne I., J. Seager, M. Mallett, and I. Sims. 2000. *Effects of Short-term Pulsed Ammonia*

Exposure on Fish. Environmental Toxicology and Chemistry: No. 19, pp. 2929-2936). Thus, repetitive exposures to sub-lethal levels of ammonia can impair and damage beneficial uses of aquatic life forms.

The Board has recently developed salinity Total Maximum Daily Load (TMDL's) objectives for the San Joaquin River at Vernalis and has proposed TMDL's for the reach upstream between the Mendota Pool Dam and Vernalis. Dairy waste is generally high in salts. In our experience, most illegal discharges from dairies occur during the winter months. Frequently, these occur during high rainfall and run-off which results in dairy lagoon overflow. The result is manure contaminated storm water from the lagoons, corrals and irrigated cropland areas flow overland and in waters of the State. Thus, we believe dairy waste discharges, at least during the winter months, is a contributing factor to salt loading into the San Joaquin River.

The U.S. Bureau of Reclamation and the California Department of Water Resources are collaborating to develop an operations model, referred to as CALSIMM II, for the operation of the Central Valley Project and the State Water Project. The San Joaquin River Water Quality Group developed a model to evaluate strategies for meeting the salinity objectives at Vernalis and the dissolved oxygen (DO) objectives in the Stockton Deep Water Ship Channel (DWSC). This model is referred to as the SANMAN Model or Recirculation Model. Both of these models predict salinity concentrations well above the Board's objectives during the winter months, and particularly in February. We believe dairy waste is a contributing salinity factor, because farmers and wetland habitat managers normally do not discharge during this time of year.

We understand the Board is in the process of developing DO objectives (TMDL's) for the Stockton DWSC near Stockton. Nutrient loading from the San Joaquin River watershed has been identified as one of the many causes of increased oxygen demand, thereby resulting in low DO to support aquatic life in the deep ship channel. The U.S. Geological Survey (USGS) has recently published their nutrient loading findings in the San Joaquin River (Charles R. Kratzer, Peter D. Dileanis, Celia Zamora, Steven R. Silva, Carol Kendall, Brian A. Bergamaschi, and Randy A. Dahlgren, 2004, *Sources and Transport of Nutrients, Organic Carbon, and Chlorophyll-a in the San Joaquin River Upstream of Vernalis, California, during Summer and Fall, 2000 and 2001*, U.S. Geological Survey, Water-Resources Investigations Report 03-4127, Sacramento, California.). A complete copy of this report can be obtained at http://pubs.usgs.gov/wri/wri034127/. Attached is an enlarged color copy of Figure 48 and the section on the isotope study results from this report. The USGS analyzed oxygen (delta oxygen 18) and nitrogen (delta nitrogen 15) isotopes to identify the nitrate sources to the San Joaquin River. Note in Figure 48 that all of the San Joaquin River nitrate sources (red squares) fall into the manure and septic waste ratio zone and most of the tributaries samples (black solid circles) fall within the soil nitrogen and fertilizer zone. This further supports the Department's view that most of the nutrient loading into the San Joaquin River is from domestic animal wastes and not from managed wetlands, which we believe has been erroneously implied by some individuals and agencies these past few years. Wetlands act as natures natural water filter and take up nutrients from the water. As examples, two cities in California, Arcata and Davis, use managed wetlands as a means for tertiary treatment for their sewer plants before discharging their waste water.

Specific Comments: Waste Discharge Requirements (WDRS)

Number 20f. The second half of this paragraph states the "This Order requires that discharges of waste from existing milk cow dairies shall not cause groundwater to be further degraded.....". We recommend this statement include "shall not cause ground water ***and surface water*** to be further degraded...." There is no definition as to the geographic scope of groundwater degradation in the General Order. Adjacent and nearby land assets (including fish and wildlife) can be impacted by both degradation of the quality and level of groundwater associated with dairy operations. The General Order should address the adjacent land impacts in a more direct manner.

Number 38. Indicates that water quality should improve if a Nutrient Management Plan is developed and implemented. The Department does not agree with this philosophy because most water quality issues arise because the dairy operators lack the storage capacity to store waste especially during the rain and run-off season.

Number 39. This paragraph emphasizes groundwater protection but does not include surface water protection.

Specific Comments: Monitoring and Reporting Program

Page 1 second paragraph, last sentence. This sentence does not make any sense. How can the operator regulatory agencies know if the operation is in compliance without a regular ongoing discharge monitoring program?

Number 6C. This sentence needs clarification because it does not make any sense.

Number 10. The paragraph refers to "wastes". Does this mean waste water?

Number 12. The first sentence should be revised as follows: "During or immediately after any overflow or other unauthorized discharge of storm water or wastewater from a manure or process wastewater storage area, retention pond, corral or land application area ***to surface water***, the Discharger shall collect samples of the discharge water."

Number 14. The first and last paragraphs seem to contradict each other. The first paragraph implies that the Discharger only needs to monitor the first 12 months and the last paragraph implies that this is not the case. Both paragraphs need clarification.

B Reporting Requirements.

Number 2 should identify a specific date the annual monitoring reports are due to the Executive Board.

The Department concurs that this is a great undertaking of the Regional Board.

If you have any questions regarding these comments please contact Dr. Andrew Gordus, Staff Environmental Scientist (Regional Water Quality Biologist), at the address or telephone number provided on this letterhead.

Sincerely,

W. E. Loudermilk

W. E. Loudermilk
Regional Manager

Attachment

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Tim Heyne
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Jerry Hatler
John Battistoni

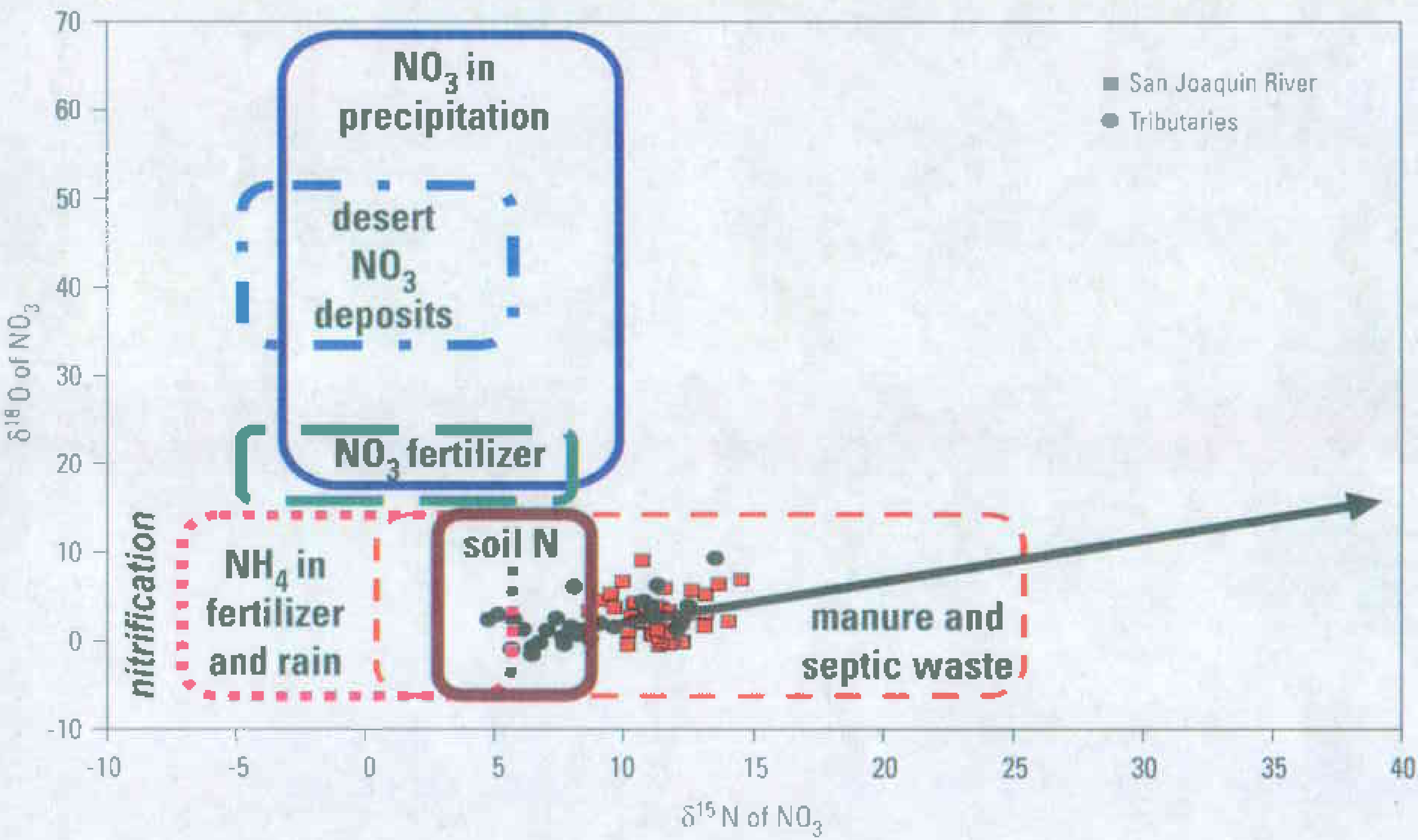

Figure 48. Delta nitrogen-15 ($\delta^{15}N$) versus delta oxygen-18 ($\delta^{18}O$) of nitrate (NO_3) for San Joaquin River, California, and tributary samples for 2001 superimposed on fields of common isotopic compositions from different nitrate sources.

(From Kendall, 1998).

ISOTOPES

Different sources of nutrients often have distinctive isotope ratios. Processes such as nitrification and denitrification can alter the isotopic composition of reactants and products. The isotopic signatures of both source and cycling mechanisms are incorporated in algae and other plants. Under favorable circumstances, both the source and cycling mechanisms of nutrients can be identified with the help of isotopic analysis. In this study, elemental and isotopes of nitrogen and carbon of POM and TDN were used to address (1) the source of POM, (2) the nutrient species responsible for phytoplankton growth, and (3) the source of the nutrients in the San Joaquin River. Isotope analysis was only done on samples collected by USGS.

Sources of Particulate Organic Matter

Four broad categories of POM source materials are phytoplankton, macrophyte detritus, soil organic matter, and terrestrial plant detritus. The source materials generally have overlapping ranges of isotopic values and carbon-to-nitrogen (C:N) ratios; however, their relative importance may be evaluated by considering together isotopic, elemental, chemical, and hydrologic data. The one unique and most diagnostic measure of the four source categories is the C:N ratio of phytoplankton, which ranges between about 5 and 8. Other sources of POM have higher C:N ratios. Macrophyte detritus ranges from about 10 to 30, soil organic matter from about 8 to 15, and terrestrial plant detritus >15 (Kendall and others, 2001).

The average atomic C:N ratio of POM for the 2000 and 2001 San Joaquin River data was 6.5 and 7.5 respectively, indicating that the POM was virtually all phytoplankton (fig. 43). The C:N ratios that fell above the range of phytoplankton values were samples from October and November when VAMP-related reservoir releases and wetland releases impacted the San Joaquin River. These higher C:N ratios reflect inputs from terrestrial sources.

Figure 44 illustrates the difference in C:N ratio and $\delta^{13}C$ of POM in the San Joaquin River and the eight tributaries sampled in 2001. The generally higher C:N ratios and $\delta^{13}C$ values in the tributaries indicate a higher fraction of nonphytoplanktonic POM than in the San Joaquin River. Of the tributaries sampled, only the POM from Mud Slough matched that found in the San Joaquin River. This match suggests significant phytoplankton growth in the San Joaquin River in addition to that entering from its tributaries.

Nitrate as a Nutrient Source to Phytoplankton

Nitrate accounted for about 90 percent of the TDN in 2000 and 2001 samples. Samples collected in 2000 were analyzed only for $\delta^{15}N$ of TDN. For samples collected in 2001, a new method for concurrent analysis of $\delta^{15}N$ and $\delta^{18}O$ of nitrate at the USGS Menlo Park Stable Isotope Laboratory allowed the analysis of a subset of archived, frozen samples directly for nitrate isotopes. This allowed us to determine how well the TDN samples represent the isotopic composition of nitrate. Figure 45 shows the $\delta^{15}N$ values of nitrate and TDN over time for the 2001 San Joaquin River samples. The TDN samples were 1.9 ±1.1‰ lower than the nitrate on average. The offset was the result of organic nitrogen with lower $\delta^{15}N$ values. In general, the estimated $\delta^{15}N$ of nitrate values determined from TDN samples were a useful representation of the nitrate isotopic values.

Note: Error wetlands are flooding up in October and November, not discharging.

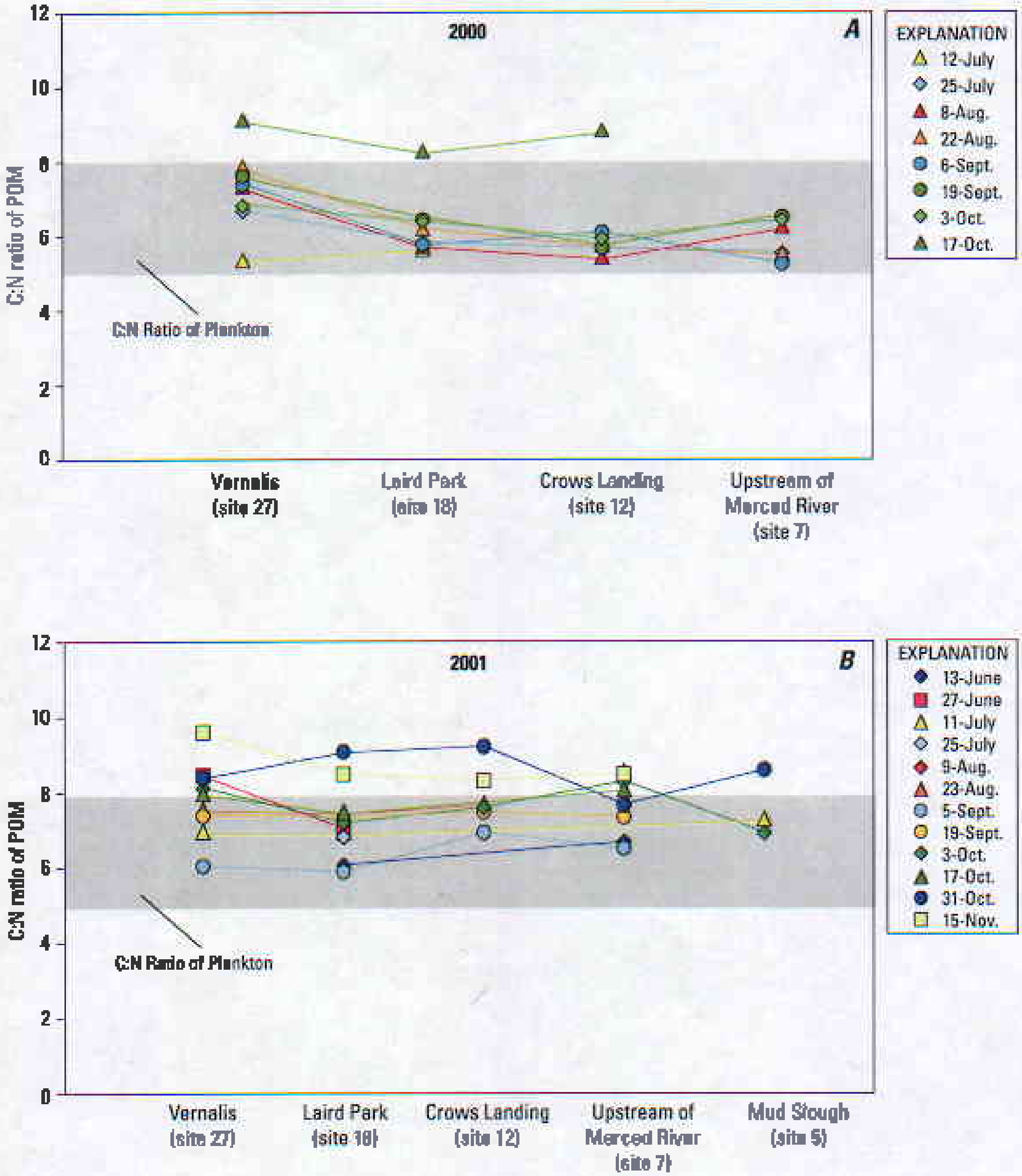

Figure 43. Atomic ratio of carbon to nitrogen (C:N) in particulate organic matter (POM) from San Joaquin River sites and Mud Slough in California.

(A) San Joaquin River sites in 2000, (B) San Joaquin River sites plus Mud Slough in 2001.

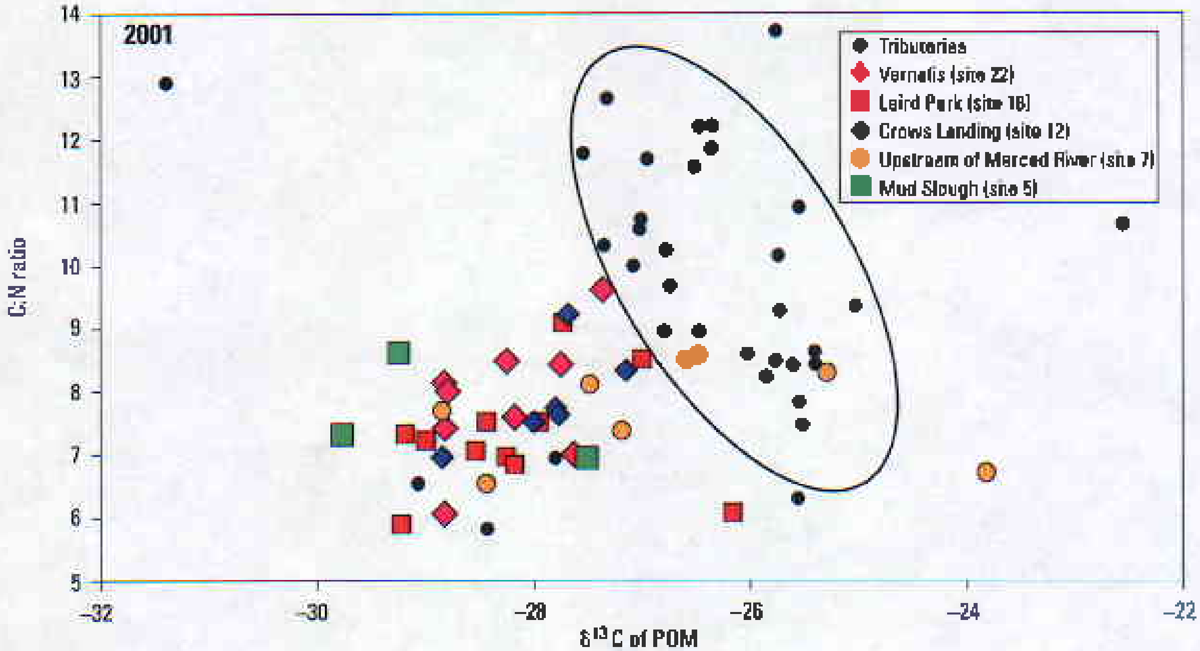

Figure 44. Atomic ratio of carbon to nitrogen (C:N) versus delta carbon-13 ($\delta^{13}C$) of particulate organic matter (POM) at San Joaquin River sites, Mud Slough, and other tributaries sampled in 2001 in California.

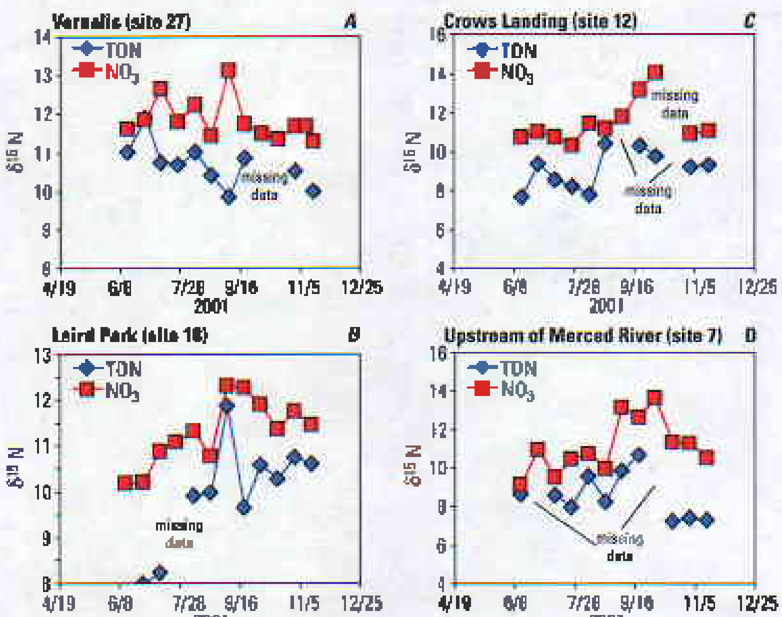

Figure 45. Delta nitrogen-15 ($\delta^{15}N$) of total dissolved nitrogen (TDN) and nitrate (NO_3) in samples from San Joaquin River, California, for 2001 (gaps indicate missing data).

(A) Vernalis, (B) Laird Park, (C) Crows Landing, and (D) Upstream of Merced River.

The $\delta^{15}N$ values of POM and TDN for the 2000 San Joaquin River samples (fig. 46) and POM and nitrate for the 2001 San Joaquin River samples (fig. 47) showed similar trends over time. When nutrients are plentiful, phytoplankton preferentially assimilate an isotopically light fraction, thus acquiring a lighter isotopic composition than their nutrient source. The data suggest that nitrate in the San Joaquin River was a significant nutrient source to the phytoplankton and, therefore, the phytoplankton either originated in the San Joaquin River or entered the river with the nitrate. Nitrate and POM data from a recent transect between Mud Slough and San Francisco Bay also strongly suggest that phytoplankton use nitrate as a significant nutrient source (Carol Kendall, U.S. Geological Survey, unpub. data from October 2002 transect, 2003).

Sources of Nitrate

Figure 48 shows the $\delta^{15}N$ and $\delta^{18}O$ values of nitrate measured in the San Joaquin River and its tributaries superimposed on the fields of common isotopic compositions from different nitrate sources (Kendall, 1998). All but a few points from the San Joaquin River fell within the range of animal waste and sewage, whereas most of the tributary values were significantly lower in a range suggesting significant amounts of soil nitrogen and (or) fertilizer. Of the tributaries, the $\delta^{15}N$ values of Mud Slough and Westport Drain fell mostly within the range of the San Joaquin River.

A possible alternative explanation for the high $\delta^{15}N$ values in the San Joaquin River is denitrification. As nitrate is microbially denitrified, the isotopic composition of nitrogen and oxygen of the residual nitrate increases in a ratio of approximately 2:1, yielding a slope of 0.5 as shown in figure 49. Denitrification occurs in anoxic environments and, therefore, it does not occur directly in the San Joaquin River. On a plot of $\delta^{15}N$ versus $\delta^{18}O$ of nitrate showing San Joaquin River samples plus Mud Slough, the data suggest denitrification for a few samples at Mud Slough and the SJR upstream of Merced River (fig. 49).

Some of the same samples with the highest $\delta^{15}N$ values had the lowest nitrate concentrations, also consistent with a limited amount of denitrification. The high $\delta^{15}N$ values and relatively high nitrate concentrations (Appendix C) at Westport Drain and Mud Slough, in contrast with the lower $\delta^{15}N$ values at other tributaries, suggest source rather than denitrification as the primary cause of the high $\delta^{15}N$ values in those tributaries and in the San Joaquin River (fig. 50). The nitrate isotopic data suggest that (1) animal waste and (or) sewage represented a significant source of nitrate in the San Joaquin River at the time of sampling, (2) the measured tributaries did not completely account for the nitrate in the San Joaquin River, and (3) that nitrate sources were locally variable in isotopic composition.

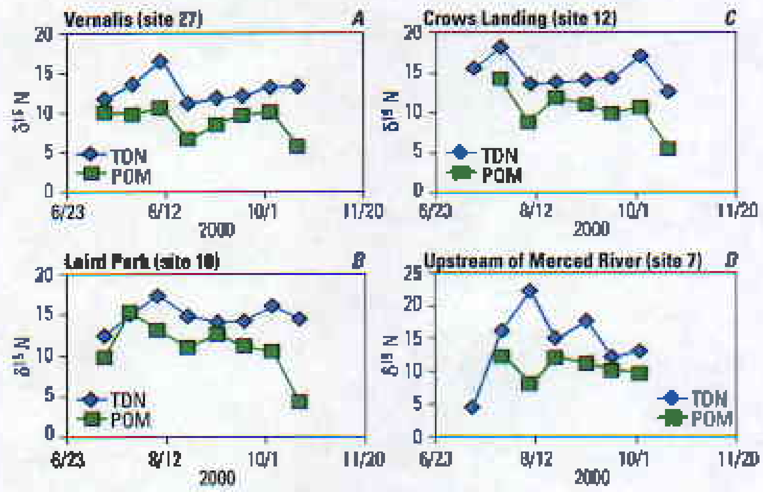

Figure 46. Delta nitrogen-15 ($\delta^{15}N$) of total dissolved nitrogen (TDN) and particulate organic matter (POM) in samples from San Joaquin River, California, for 2000.

(A) Vernalis, (B) Laird Park, (C) Crows Landing, and (D) Upstream of Merced River.

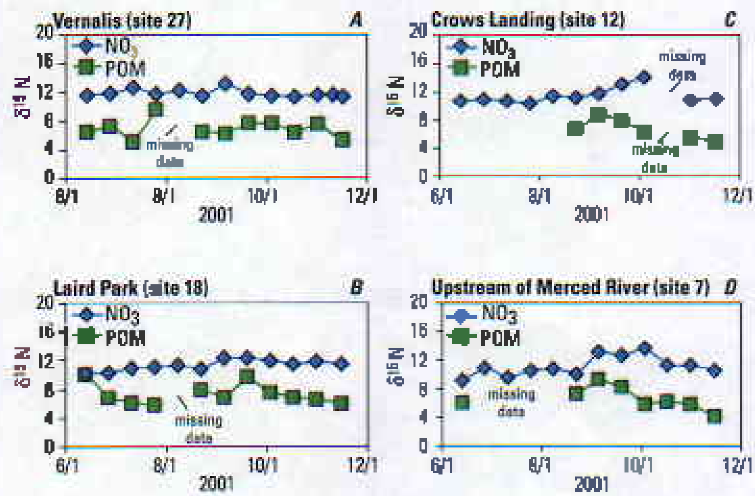

Figure 47. Delta nitrogen-15 ($\delta^{15}N$) of nitrate (NO_3) and particulate organic matter (POM) in samples from San Joaquin River, California, for 2001 (gaps indicate missing data).

(A) Vernalis, (B) Laird Park, (C) Crows Landing, and (D) Upstream of Merced River.

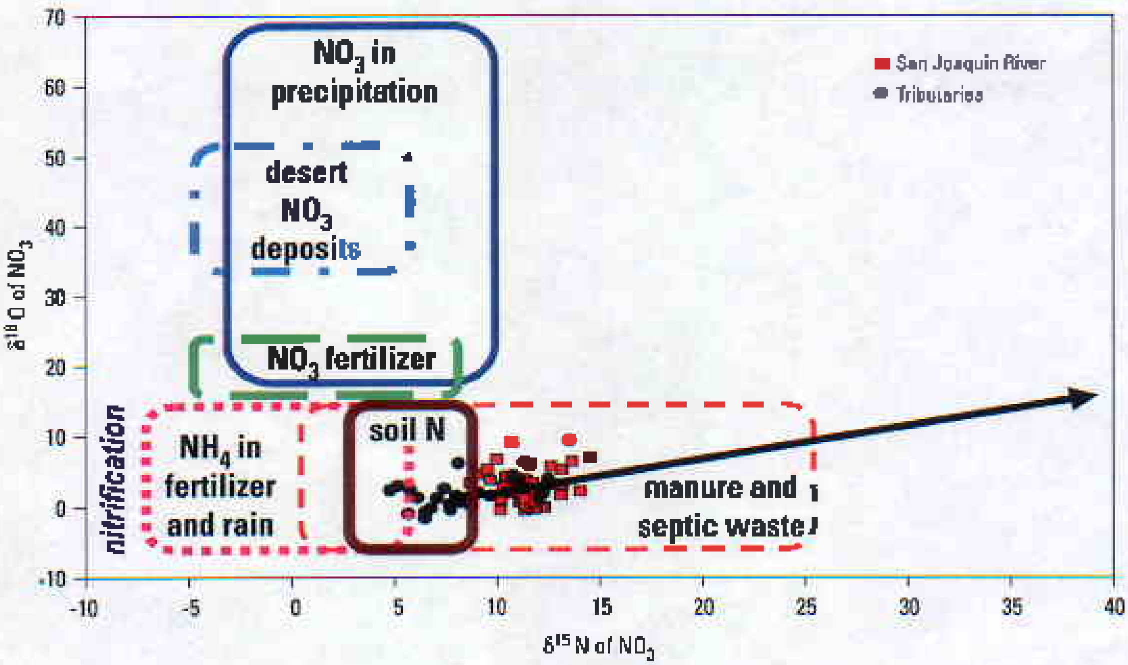

Figure 48. Delta nitrogen-15 (δ^{15}N) versus delta oxygen-18 (δ^{18}O) of nitrate (NO_3) for San Joaquin River, California, and tributary samples for 2001 superimposed on fields of common isotopic compositions from different nitrate sources.

(From Kendall, 1998).

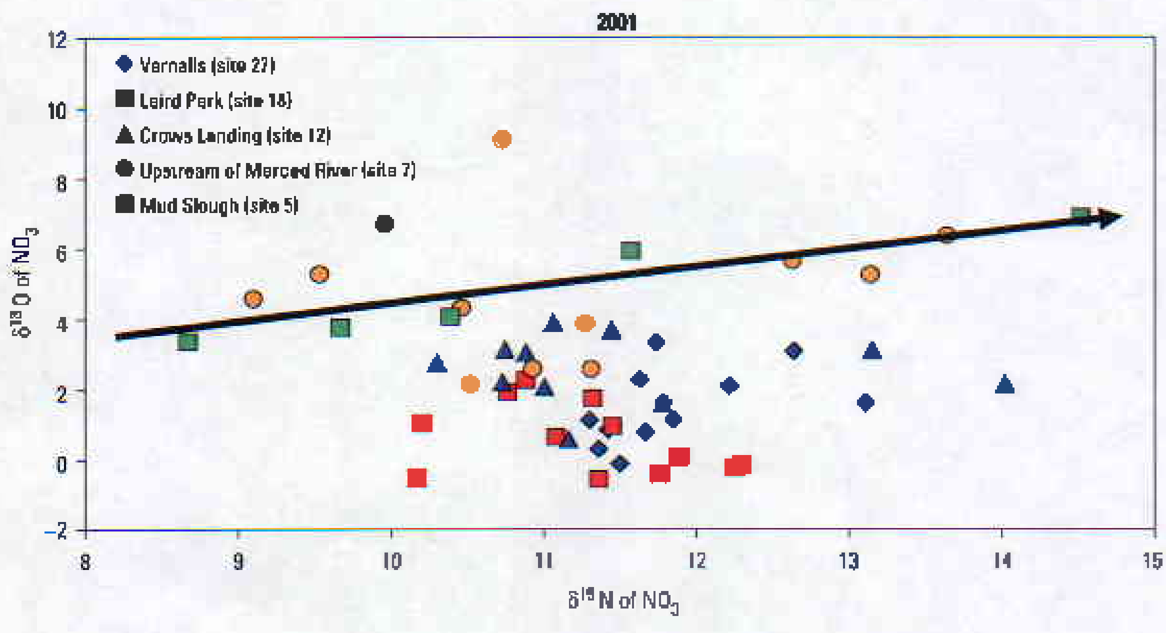

Figure 49. Delta nitrogen-15 (δ^{15}N) versus delta oxygen-18 (δ^{18}O) of nitrate (NO_3) for San Joaquin River, California, and tributary samples for 2001 with possible denitrification trend line.

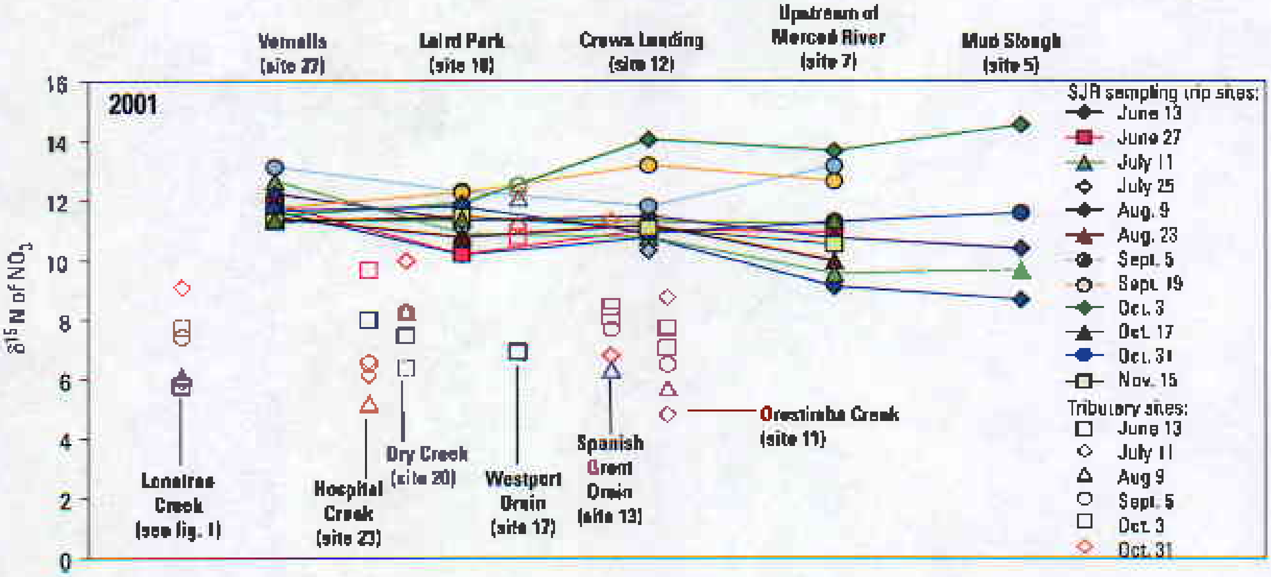

Figure 50. Delta nitrogen-15 ($\delta^{15}N$) of nitrate (NO3) for San Joaquin River, California, and tributary samples for 2001.

SJR, San Joaquin River.

SUMMARY AND CONCLUSIONS

Samples were collected and analyzed by USGS in July through October 2000 at four San Joaquin River sites and in June through November 2001 at the same four sites plus eight tributary sites. The data for these sites are supplemented in this report with data from samples collected and analyzed by UCD from three San Joaquin River sites and eight tributary sites as part of a separate study. Streamflows in the San Joaquin River were slightly above the long-term average in 2000 and slightly below average in 2001. There were several differences in the methods used by USGS and UCD for sample collection and laboratory analyses. As a result of quality control data comparing the different methods, we do not report the UCD pheophytin-*a* data and do not consider the USGS VSS and the UCD POM data to be comparable.

The median concentrations at San Joaquin River sites in 2000 and 2001 were 2.67 and 2.60 mg/L for nitrate, 0.12 mg/L for orthophosphate, 3.9 mg/L for DOC, and 27.2 and 29.4 µg/L for chlorophyll-*a*. The median concentrations of all tributary samples in 2000 and 2001 were 2.66 mg/L for nitrate, 0.08 mg/L for orthophosphate, 4.3 mg/L for DOC, and 6.0 µg/L for chlorophyll-*a*.

Nitrate loads near Vernalis in 2000 were above the long-term average, whereas loads in 2001 were about average. Total nitrogen loads in 2000 were slightly above average, whereas loads in 2001 were slightly below average. Total phosphorus loads in 2000 and 2001 were well below the long-term average. These loads correspond with the flow-adjusted concentration trends for these constituents—nitrate has significantly increased since 1972 ($p < 0.01$), whereas total nitrogen and total phosphorus have not ($p > 0.05$).

Loading rates of nutrients and organic carbon increased in the San Joaquin River in October and November with the release of wetland drainage into Mud Slough and the increased reservoir releases on the Merced River as part of the Vernalis Adaptive Management Plan (VAMP). Chlorophyll-*a* loading rates and concentrations declined in the San Joaquin River during August in 2000 and September in 2001. Irrigation diversions from the San Joaquin River in June through August have a significant impact on the pattern of upstream to downstream loading rates, especially in the reach from Crows Landing to Maze Road.

Note: Error wetlands are flooding up in October and November, not discharging.

The most significant tributary sources of nitrogen and phosphorus to the San Joaquin River were the Tuolumne River, Harding Drain, and Mud Slough. These tributaries individually accounted for as much as 20 to 27 percent of the nitrogen loading rate at SJR near Vernalis, and as much as 51 to 76 percent of the phosphorus loading rate near Vernalis during a sampling period. The most significant sources of DOC were Salt Slough, Mud Slough, and the Tuolumne and Stanislaus Rivers. These tributaries accounted for as much as 24 to 45 percent of the DOC loading rate at SJR near Vernalis. During the VAMP-related reservoir releases in October 2000, the Merced River accounted for 28 percent of the DOC loading rate at SJR near Vernalis. Mud Slough was the only tributary to account for as much as 15 percent of the chlorophyll-*a* loading rate near Vernalis; this occurred in September and October 2001. Generally, compared with nutrients and DOC, tributaries were minor sources of chlorophyll-*a* loading rate, suggesting that most of the chlorophyll-*a* is produced in the San Joaquin River instead of entering from the tributaries.

On the basis of carbon-to-nitrogen ratios and the $\delta^{13}C$ of POM in the San Joaquin River and tributaries, the POM in the San Joaquin River was primarily comprised of phytoplankton. Of the tributaries sampled, only the POM in Mud Slough had a signature consistent with the San Joaquin River. This is consistent with the above conclusion that Mud Slough was the largest tributary source of chlorophyll-*a*. On the basis of the $\delta^{15}N$ values of POM, TDN, and nitrate, the nitrate in the San Joaquin River appears to be a significant nutrient source to the phytoplankton. The range of $\delta^{15}N$ and $\delta^{18}O$ values of nitrate in the San Joaquin River and tributaries suggest that animal waste or sewage was a significant source of nitrate in the San Joaquin River at the time of sampling. This signature was higher in east-side tributaries than in west-side tributaries. The west-side sources were more suggestive of a soil nitrogen or fertilizer source. Denitrification may have been a reason for some high $\delta^{15}N$ samples in Mud Slough and the SJR upstream of Merced River.

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